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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte XING SU and ANDREW A. BERLIN

Appeal 2010-010724
Application 10/697,682
Technology Center 1600

Before ERIC GRIMES, LORA M. GREEN, and
JACQUELINE WRIGHT BONILLA, *Administrative Patent Judges*.

BONILLA, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134 involving claims directed to a method for identifying and sequencing proteins and peptides. The Examiner has rejected the claims as anticipated and/or obvious. We have jurisdiction under 35 U.S.C. § 6(b). We reverse.

STATEMENT OF THE CASE

The claims are directed to a method for identifying and/or sequencing proteins or peptides by generating distance maps. The method involves passing labeled proteins, polypeptides or peptides through nanopores, where the inner surfaces of the nanopores are coated with a semiconductor material.

Claims 1-8, 10-16, and 32-35 are on appeal. Claim 1 is the only independent claim and reads as follows (emphasis added):

> 1. A method comprising:
>
> a) placing a plurality of labeled proteins, polypeptides or peptides in a plurality of chambers, such that different chambers contain a different type of labeled amino acid;
>
> b) passing the labeled proteins, polypeptides or peptides through one or more nanopores, *an inner surface of the nanopores coated with a semiconductor material*;
>
> c) detecting labeled amino acid residues in the labeled proteins, polypeptides or peptides;
>
> d) compiling an amino acid distance map for each type of labeled amino acid; and
>
> e) identifying the protein based on the distance maps.

The claims stand rejected as follows:

• Claims 1, 4, 5, 7, 8, 10-14, 16, and 35 under 35 U.S.C. § 102(b) as anticipated by Chan (U.S. Pat. No. 6,210,896, issued Apr. 3, 2001) ("Chan '896").

• Claims 1, 4, 5, 7, 8, 10-14, 16, and 35 under 35 U.S.C. § 102(e) as anticipated by Chan (U.S. Pat. No. 6,355,420, issued Mar. 12, 2002) ("Chan '420").

• Claims 1, 3-5, 7, 8, 10-14, 16, and 35 under 35 U.S.C. § 103(a) as obvious over Chan '896.

• Claims 2, 6, 15, and 32-34 under 35 U.S.C. § 103(a) as obvious over Chan '896 in view of Thompson et al. (U.S. Pat. No. 5,324,637, issued Jun. 28, 1994.).

I.

Issue

The first issue relates to claim construction. Specifically, how should the term "semiconductor material" be interpreted in the phrase "an inner surface of the nanopores coated with a semiconductor material" in (b) of claim 1?

Findings of Fact

1. The instant Specification states in paragraph [0067] on page 15 (emphasis added):

> Nanopores, nanotubes and/or nanochannels may penetrate one or more sensor layers. *The sensor layers may comprise <u>semiconductor materials</u> including, but not limited to, silicon, silicon dioxide, silicon nitride, germanium, gallinium arsenide, <u>and/or metal-based compositions such as metals or metal oxides</u>*. Sensor layers may be processed by electronic beam, ion beam and/or laser lithography and etching to create a channel, groove, or hole. Conducting layers comprising metals may be deposited onto a semiconductor surface by means of field evaporation from a scanning tunnel microscope (STM) or atomic force microscope (AFM) tip or from a solution. Insulating

> layers may be formed by oxidizing the semiconductor's surface to an insulating composition.

2. The Examiner interprets the term "semiconductor material" in claim 1 in light of paragraph [0067] in the instant Specification. (Ans. 18.) According to the Examiner, the "specification uses the conjunction 'and/or'," which "implies that semiconductor materials include silicon, silicon dioxide, silicon nitride, germanium, gallinium arsenide and metal-based compositions." (*Id.*)

3. Appellants provide evidence, in the form of a printout of a Wikipedia website article dated February 13, 2009 ("Wikipedia printout"). Citing this article, Appellants argue that one of skill in the art would understand that a "semiconductor" differs from a "metal." (App. Br. 5.)

4. In a section entitled "Energy bands and electrical conduction," the Wikipedia printout states that: "Semiconductors and insulators are distinguished from metals because the valence band in the semiconductor materials is very nearly full under usual operating conditions, thus causing more electrons to be available in the conduction band." (Wikipedia printout, page 3 of 9.)

5. In a section entitled "Energy-momentum dispersion," the Wikipedia printout states that "[m]aterials … such as silicon and germanium, are known as *indirect bandgap* materials. Materials in which the band extrema are aligned in k, for example gallium arsenide, are called *direct bandgap* semiconductors." (Wikipedia printout, page 5 of 9.)

Principles of Law

"[D]uring examination proceedings, claims are given their broadest reasonable interpretation consistent with the specification." *In re Hyatt*, 211 F.3d 1367, 1372 (Fed. Cir. 2000). The PTO "determines the scope of claims in patent applications not solely on the basis of the claim language, but upon giving claims their broadest reasonable construction 'in light of the specification as it would be interpreted by one of ordinary skill in the art.'" *Phillips v. AWH Corp.,* 415 F.3d 1303, 1316 (Fed. Cir. 2005) (quoting *In re Am. Acad. of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364 (Fed. Cir. 2004)).

We interpret a claim term in a manner "that is different from the ordinary meaning when 'the patentee acted as his own lexicographer and clearly set forth a definition of the disputed claim term in … the specification ….'" *Edwards Lifesciences LLC v. Cook Inc.*, 582 F.3d 1322, 1329 (2009) (quoting *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002)). In this regard, when one "acts as his own lexicographer in redefining the meaning of particular claim terms away from their ordinary meaning, he must clearly express that intent in the written description." *Merck & Co., Inc. v. Teva Pharmaceuticals USA, Inc.*, 395 F.3d 1364, 1370 (2005).

Analysis

When interpreting the phrase "semiconductor material," the Examiner relies on the sentence in paragraph [0067] of the instant Specification that states (emphasis added): "The sensor layers may comprise *semiconductor materials including*, but not limited to, silicon, silicon dioxide, silicon nitride, germanium, gallinium arsenide, *and/or metal-based compositions*

such as metals or metal oxides." (FF 1.) The Examiner asserts that if Appellants "wanted to clearly define that semiconductor material excluded metal-based compositions, the specification would have recited 'or' only, to clearly delineate that metal-based compositions are not semiconductors." (Ans. 18.) Thus, the Examiner places significance on the fact that this sentence in the Specification uses "and/or" instead of "or" when discussing sensor layers, semiconductor material, and metal-based compositions. Based on this word choice, according to the Examiner, the term "semiconductor material" in claim 1 encompasses metal-based compositions, such as metals.

Appellants, on the other hand, read the same sentence in paragraph [0067] of the Specification differently. According to Appellants, the sentence describes various possible sensor layer components, and teaches that the *sensor layers* may comprise: (1) semiconductor materials; and/or (2) metal-based compositions, such as metal. (App. Br. 5.) In other words, the sentence does not indicate that "semiconductor material" includes metals.

Appellants rely on evidence in the form of a submitted printout of a Wikipedia article on "Semiconductor," dated February 13, 2009. (*Id.*; FF 3.) In this context, Appellants discuss the differences between a "semiconductor" and a "metal," indicating that semiconductors and insulators have a band gap between the valence and conduction bands, with semiconductors having smaller band gaps relative to insulators, while metals do not have a band gap. (App. Br. 5.) According to Appellants, the lack of a band gap is a "fundamental difference between metal and a

semiconductor." (*Id.*) Appellants also argue that "even if the second sentence of paragraph [0067] were read to include 'metal based compositions,' the metal based compositions would still have to be semiconducting," i.e., they would have a "band gap and no longer exhibit 'metallic' properties." (Reply Br. 5-6.)

While a Wikipedia article does not necessarily carry the same evidentiary weight as a peer-reviewed scientific article or a technical dictionary, the Wikipedia printout does provide some evidence of what was well-known to those skilled in the art of semiconductor material. Moreover, the Examiner does not dispute that the Wikipedia printout describes that semiconductors differ from metals or that the printout provides evidence of a general understanding by those skilled in the art regarding the definition of "semiconductor material," as distinct from "metals." Rather, the Examiner appears to assume that Appellants act as their own lexicographer and define "semiconductor material" as including metals, as dictated by the above-mentioned sentence in paragraph [0067] of the Specification.

We do not see that the relevant sentence in paragraph [0067] mandates such a reading, however. On its face, the sentence can be read two different ways, i.e., that (1) sensor layers may comprise (i) semiconductor materials, and/or (ii) metal-based compositions; or (2) sensor layers may comprise certain components, including semiconductor materials, such as metals. As stated by the Federal Circuit, when one "acts as his own lexicographer in redefining the meaning of particular claim terms away from their ordinary meaning, he must clearly express that intent in the written description," i.e., the Specification. *Merck*, 395 F.3d at 1370. The

Specification here does not "clearly express" a definition of "semiconductor material" that is contrary to its ordinary meaning, as evidenced by the Wikipedia printout. *See, e.g.*, Wikipedia printout, page 3 of 9, section entitled "Energy bands and electrical conduction" (stating that "Semiconductors and insulators are distinguished from metals because....") (FF 4.)

The Examiner asserts that "both germanium and gallinium are metal based compositions," and "it is well known in the art that metal is a known semiconductors. Most metals are semiconductors in some capacity." (Ans. 18-19.) As noted by Appellants, however, the Examiner provides no evidentiary support for these assertions. (Reply. Br. 6.)

On the other hand, the Wikipedia printout discusses germanium and gallium arsenide, stating, for example, that materials such as silicon and germanium "are known as *indirect bandgap* materials," while "[m]aterials in which the band extrema are aligned in k, for example gallium arsenide, are called *direct bandgap* semiconductors." (Wikipedia printout, page 5 of 9, section entitled "Energy-momentum dispersion".)

This disclosure in the Wikipedia printout is therefore consistent with the following statements by Appellants:

> Germanium, like silicon, has a band gap. That is, in contrast to the Examiner's assertion, Germanium is a semiconductor, not a metal. Gallium, unalloyed, is a metal, not a semiconductor. When Gallium (a group III metal) is alloyed with a group V element (N, P, Sb, As) in a roughly 50:50 composition, a compound semiconductor may be formed. The compound semiconductor no longer has the properties of metallic gallium. Thus, neither germanium nor gallium (when alloyed) can be considered "metal based compositions" as used by the examiner.

(Reply Br. 7.) In other words, Appellants' evidence indicates that germanium and gallinium arsenide act as semiconductors, not as metals, which have no band gap. The Examiner provides no evidence to the contrary.

Conclusion of Law

Based on claim language, disclosures in the Specification, and evidence before us regarding the plain meaning of the term "semiconductor material," we conclude that the Examiner erred in interpreting this term. We interpret the term "semiconductor material" to include material such as silicon, silicon dioxide, silicon nitride, germanium and gallinium arsenide, but not metal-based compositions, such as metals, that do not act as semiconductors.

II.

Issue

The next issue is whether the references cited by the Examiner, i.e., Chan '896, Chan '420, and Thomson, teach and/or suggest a method comprising the passage of labeled proteins, polypeptides or peptides through a nanopore, where the inner surface of the nanopore is "coated with a semiconductor material."

Additional Findings of Fact

6. In Example 6, Chan '896 teaches that "Polymer **39** is pulled closer to tip **70** using dielectric forces created by applying an AC field to electrode **85** and waveguide **66**, i.e., *metal layers* **64** and **74**, in addition to the DC field applied across wires **98A** and **98B**. The AC field applied capacitively with

respect to the DC field *generates an inhomogeneous field in nanochannel* 71." (Chan '896, col. 36, ll. 14-19 (emphasis added).)

7. The Examiner refers to the above-quoted passage in Chan '896 as "meeting the limitation of inner surface of the nanopores coated with a semiconductor material," as recited in claim 1. (Ans. 6, 17.)

8. The Examiner states that the "semiconductor material" of claim 1 "includes metal-based compositions, and Chan '896 teaching the metal layer would inherently have all of the properties of semiconductor material of instant claims." (Ans. 19.)

9. Chan '420 also describes "nanochannels," and teaches that:

> Nanochannels can be prepared by electroless deposition procedures which produce *a metal fibril* running the complete width of a polycarbonate template membrane. The membrane can also be produced such that both faces of the membrane are covered with *thin metal films* to produce a nanodisk electrode ensemble, one of the metal films can be removed to expose the surface of the membrane. The metal films can be removed to expose the surface of the membrane. These electrodes can be connected at their bases to a common current collector. This assembly is useful for examining changes in current as polymers flow through changes in conductance can be measured.

(Chan '420, col. 46, ll. 15-26 (emphasis added).)

10. According to the Examiner, the above-quoted passage in Chan '420 describes an inner surface of a nanopore "coated with a semiconductor material," as recited in claim 1. (Ans. 11, 19.)

11. The Examiner states that the "semiconductor material" of claim 1 "includes metal-based compositions, and Chan '420 teaching the metal films

would inherently have all of the properties of semiconductor material of instant claims." (Ans. 20.)

12. The Examiner relies on Thompson as "provid[ing] a simple method for producing protein from a template DNA," and "radiolabeling of proteins." (Ans. 14-15, 21-22.)

Principles of Law

The Examiner bears the initial burden, on review of the prior art, of presenting a prima facie case of unpatentability. *In re Oetiker*, 977 F.2d 1443, 1445 (1992). If the Examiner meets that initial burden, the burden of coming forward with evidence or argument shifts to the applicant. *In re Rijckaert*, 9 F.3d 1531, 1532 (Fed. Cir. 1993). After the applicant submits evidence or argument, the PTO then determines patentability "on the totality of the record, by a preponderance of evidence with due consideration to persuasiveness of argument." *Oetiker*, 977 F.2d at 1445. If the Examiner fails to establish a prima facie case of unpatentability in the first instance, however, the rejection is improper and must be reversed. *Id.*; *Rijckaert*, 9 F.3d at 1532.

In order for a prior art reference to serve as an anticipatory reference, it must disclose every limitation of the claimed invention, either explicitly or inherently. *See, e.g., In re Schreiber*, 128 F.3d 1473, 1477 (Fed. Cir. 1997).

An obviousness analysis compares the claimed invention and the prior art to determine whether "the subject matter as a whole would have been obvious at the time the invention was made" to a person having ordinary skill in the art. *Alza Corp. v. Mylan Labs., Inc.*, 464 F.3d 1286, 1289 (Fed. Cir. 2006). The ultimate question of obviousness is one of law,

based upon factual inquiries set forth in the *Graham* case: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims at issue; (3) the level of ordinary skill in the pertinent art; and (4) objective evidence of non-obviousness, if any. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966).

Analysis

In the anticipation and obviousness rejections, the Examiner asserts that Chan '862 and Chan '420 each teach "nanopores coated with a semiconductor material" as recited in claim 1 because each reference teaches nanochannels coated with "metal" layers, fibril or films. (FF 6-11.) The Examiner states that "semiconductor material includes metal-based compositions," such as the "metal" disclosed in the two Chan references. (FF 8, 11.) According to the Examiner, Chan '896 and Chan '420 each teach that the metal layer, fibril or films "would inherently have all of the properties of semiconductor material of instant claims." (*Id.*)

The Examiner makes these statements without citing to any evidence in support. At most, the Examiner appears to rely on claim interpretation arguments to support the assertion that any "metal" falls into the definition of "semiconductor material." As discussed in the claim interpretation section above, however, we interpret the term "semiconductor material" to exclude metal-based compositions, such as metals, that do not act as semiconductors.

The Examiner provides no evidence that the "metal" layer, fibril and/or films disclosed in the Chan references act, or are capable of acting, as semiconductors. Rather, the Examiner asserts "it is well known in the art

that metal is a known semiconductors" and that "[m]ost metals are semiconductors in some capacity," without citing any evidence in support. (Ans. 18-19, 20, 21.) By contrast, Appellants provide evidence that metals differ from semiconductors in that metals do not have a band gap. The Examiner points to no evidence indicating that "most metals" have a band gap, or otherwise act as semiconductors.

Thus, we find that the Examiner has not established a prima facie case of anticipation regarding either Chan reference. The Examiner has not provided any evidence that the "metal" layers, fibril or films disclosed in those references, inherently or otherwise, act as semiconductor materials. Beyond pointing to the use of the word "metal," the Examiner has not directed us to any disclosure in these references of "nanopores coated with a semiconductor material" as recited in claim 1. Without more, the Examiner has not met the required burden to establish a prima facie case.

Notably, in the obviousness rejections, the Examiner relies on the exact same points raised in the anticipation rejections with regard to the Chan references. In this capacity, the Examiner does not assert, much less provide any evidence, that one of skill in the art would have had reason to substitute a semiconductor material for the metal in the "metal" layers, fibril or films disclosed in the Chan references. (*See* Ans. 13-22.)

In certain obviousness rejections, the Examiner also relies on the Thompson reference as "provid[ing] a simple method for producing protein from a template DNA," and "radiolabeling of proteins." (Ans. 14-15, 21-22.) In other words, the Examiner does not assert that Thompson teaches or suggests nanopores coated with a semiconductor material. (Ans. 13-22.).

The Examiner relies on Chan '896 and Chan '420 as evidence of such teachings in the prior art. For the reasons discussed above, the mere disclosure of a "metal" in the Chan references is insufficient to establish that these references teach or suggest a semiconductor material.

Thus, the Examiner has failed to establish a prima facie case of obviousness based on Chan '896, either alone or in combination with Thompson. The Examiner has not provided any evidence that any cited reference, alone or in combination with the other references, teaches or suggests to one of skill in the art a method comprising "passing the labeled proteins, polypeptides or peptides through one or more nanopores, an inner surface of the nanopores coated with a semiconductor material," as recited in (b) of claim 1.

Conclusion of Law

We conclude that the references cited by the Examiner, i.e., Chan '896, Chan '420, and Thompson, fail to teach and/or suggest a method comprising the passage of labeled proteins, polypeptides or peptides through a nanopore, where the inner surface of the nanopore is "coated with a semiconductor material." Thus, the Examiner has failed to establish a prima facie case of anticipation or obviousness with regard to claim 1. Because dependent claims 2-8, 10-16, and 32-35 all depend on independent claim 1, and likewise require (b) as recited in claim 1, the Examiner has failed to present a prima facie case of unpatentability regarding these claims as well.

SUMMARY

We reverse the rejection of claims 1, 4-5, 7-8, 10-14, 16 and 35 as anticipated by either Chan '896 or Chan '420. We also reverse the rejection of claims 1, 3-5, 7-8, 10-14, 16 and 35 as obvious over Chan '896. In addition, we reverse the rejection of claims 2, 6, 15 and 32-34 as obvious over Chan '896 in view of Thompson.

REVERSED

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